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New taxa and new reports of *Phyllopsora* (lichenized *Ascomycotina*) from India

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Abstract— An account of 14 species of *Phyllopsora* from India is provided. *P. catervisorediata* and *P. himalayensis* are described as new species, while *P. corallina* var. *subglaucella* as a new variety. *P. albicans, P. breviuscula, P. chlorophaea, P. confusa, P. isidiotyla, P. kalbii, P. mauritiana, P. nemoralis, P. subcrustacea,* and *P. swinscowii* are new records for the Indian lichen biota.

Key words— *Ramalinaceae*, *Ascomycetes*, squamulose, taxonomy

Introduction

The genus *Phyllopsora* is characterised by a crustose to squamulose thallus, thin to thick, white to brown to reddish brown prothallus, minute to subfoliose squamules which are corticated on upper side, green alga photobiont, convex, biatorine apothecia with a hyaline to pale yellow epihymenium, hyaline to reddish-brown exciple, hyaline to yellowish-brown hymenium, hyaline or golden yellow to brownish hypothecium, simple to conglutinated paraphyses, 8-spored asci and hyaline, simple, ellipsoid, bacilliform to fusiform ascospore. The species of *Phyllopsora* mostly inhabit bark but sometimes grow on rock and bryophytes. The species exhibit wide ranges of altitudinal distribution from sea level up to an height of 3000 m.

Phyllopsora (*Ramalinaceae*) is a common lichen genus in tropical and subtropical areas of the world. Swinscow & Krog (1981) revised the East African species of *Phyllopsora* and reported the occurrence of eleven species from the region. Brako (1989, 1991) monographed the neotropical flora and enumerated eighteen species and eight varieties. Timdal & Krog (2001) studied

the East African and Mascarene *Phyllopsora* species. Elix (2006a, b) recorded five new species of *Phyllopsora* from Australia and for the first time Timdal (2008) described sorediate *Phyllopsora* species from Peru.

Upreti et al. (2003) described five species of *Phyllopsora* from India. Later, Awasthi (2007) updated the occurrence of six taxa of *Phyllopsora* from India, where *P. kiiensis* (Vain.) Gotth. Schneid. was considered to be a synonym of *P. haemophaea* (Nyl.) Müll. Arg. However, it is clear from our study and according to Timdal & Krog (2001) that *P. kiiensis* is a distinct species, while *P. haemophaea* is a synonym of *P. furfuracea* (Brako 1991). The known taxa of *Phyllopsora* from India prior to the present communication include *P. buettneri* (Müll. Arg.) Zahlbr., *P. corallina* (Eschw.) Müll. Arg., *P. furfuracea, P. kiiensis, P. manipurensis* (Müll. Arg.) Gotth. Schneid., *P. parvifolia* (Pers.) Müll. Arg. var. *parvifolia*, and *P. parvifolia* var. *subgranulosa* (Tuck.) Müll. Arg. The present investigation adds further 13 taxa of *Phyllopsora* to the Indian lichen biota, including two new species and one new variety. The description and illustration of *P. furfuracea* is also provided here for better understanding of the taxa.

Materials & methods

The present study is based on the lichen specimen preserved at the herbarium of the National Botanical Research Institute, Lucknow (LWG), which also includes the personal herbarium of Dr. Awasthi (LWG-AWAS). The specimens were examined morphologically, anatomically, and chemically. Thin hand-cut sections of apothecia and thallus were mounted in plain water, cotton blue and 5% KOH and observed under a compound microscope. For chemical spot tests the usual reagents of K, C and P were used. TLC was performed in solvent system A, following Walker & James (1980). Swinscow & Krog (1981) was followed for the terminology of cortex types.

Key to the Indian *Phyllopsora* taxa

1. Thallus isidiate or sorediate 2
1a. Thallus otherwise 11
2. Thallus sorediate . . . . . *P. catervisorediata*
2a. Thallus isidiate 3
3. Isidia mostly globular 4
3a. Isidia mostly cylindrical 5
4. Thallus greenish, upper cortex type 2; apothecia brown to black, K– . . . . *P. kalbii*
4a. Thallus yellowish, upper cortex type 1–2; apothecia dark brown, K+ yellow . . . . . *P. himalayensis*
5. Squamules 0.3–1.5 mm wide 6
5a. Squamules 0.1–0.3 mm wide 8
6. Thallus containing methyl 2,7-dichloropsoromate and methyl 2,7-dichloronorpsoromate . . . . . *P. swinscowii*

6a. Thallus chemistry otherwise. 7
7. Thallus containing furfuraceic acid . . . . . *P. kiiensis*
7a. Thallus lacking furfuraceic acid . . . . . *P. corallina* var. *corallina*
8. Thallus K–, containing furfuraceic acid. . . . . *P. furfuracea*
8a. Thallus K+ yellow, lacking furfuraceic acid 9
9. Isidia mostly bulbate at the base, thick; apothecia brown . . . . . *P. corallina* var. *subglaucella*
9a. Isidia simple or coralloid, common to abundant; apothecia brown to black . . . 10
10. Isidia thick, irregular shaped; upper cortex thin, gelatinous . . . . . *P. isidiotyla*
10a. Isidia thin, short; upper cortex type 1–2 . . . . . *P. nemoralis*
11. Squamules 0.1–0.3 mm wide. 12
11a. Squamules 0.3–1.5 mm wide. 16
12. Prothallus reddish brown to black; squamules ascending . . . . . *P. chlorophaea*
12a. Prothallus white or red; squamules adnate to ascending 13
13. Prothallus red; hypothecium colourless . . . . . *P. parvifolia* var. *subgranulosa*
13a. Prothallus white; hypothecium yellowish to reddish brown 14
14. Squamules yellowish to greenish; hypothecium dark brown . . . . . *P. manipurensis*
14a. Squamules greenish; hypothecium golden yellow to reddish brown 15
15. Ascospores 11–18 × 2–3 µm; apothecia with fibrillose margin . . . *P. subcrustacea*
15a. Ascospores 8–11 × 1–2 µm; apothecia glabrous margin. . . . . *P. confusa*
16. Thallus PD+ orange, red 17
16a. Thallus PD– 18
17. Squamules mostly pruinose, strongly pubescent, not imbricate . . . . . *P. buettneri*
17a. Squamules not pruinose, rarely pubescent, imbricate. . . . . *P. albicans*
18. Squamules mostly ascending, upper side yellowish brown, pubescent at margin . . . . . *P. parvifolia* var. *parvifolia*
18a. Squamules adnate to ascending, upper side greenish, margin occasionally pubescent 19
19. Squamules closely adnate, overlapping; hypothecium colourless to pale brown . . . . . *P. mauritiana*
19a. Squamules ascending; hypothecium golden yellow to brown . . . . . *P. buettneri*

The species

Phyllopsora albicans Müll. Arg., Bull. Soc. R. Bot. Belg. 32: 132 (1893). Fig. 1

Prothallus thin to thick, reddish brown. Thallus squamulose, ascending, mainly imbricate, elongate, incised to deeply divided, 0.3–1.0 mm wide; upper surface glabrous to slightly pubescent, pale green to dark green, plane to convex, margin pubescent. Isidia absent. Cortex 1–2 type, 12–20 µm thick; medulla containing crystals, dissolving in K.

Apothecia rare, up to 1.5 mm diam.; disc plane to convex, reddish brown; margin raised. Exciple reddish-brown; epihymenium hyaline; hymenium colourless to pale yellow; hypothecium golden yellow and containing crystals which dissolve in K. Ascospores hyaline, simple to narrowly ellipsoidal to bacilliform, 6–10 × 1–2 µm. Pycnidia not seen.

Chemistry — Thallus K–, C–, KC–, PD+ yellow orange; argopsin and pannarin in TLC.

Specimens examined — **India: Arunachal Pradesh**, Upper Siang district, Jengging, Apanavan area, alt. 1014 m, on bark, 18.11.2008, D.K. Upreti, U. Dubey, R. Khare & G. Mishra 08-009322 (LWG), West Siang district, Eyi village, on bark, 17.10.2007, U. Dubey s.n. (LWG), **Kerala**, Palghat district, Silent Valley National Park, on *Mesua ferea* bark, 24.11.2006, B. Haridas 06-014751 (LWG).

Remarks — *Phyllopsora albicans* is distinguished by the elongated, often imbricate squamules. It is close to *P. buettneri* in having a PD+ orange reaction (pannarin or related compounds), but the later species differs in having pruinose, strongly pubescent squamules containing additionally zeorin. *P. albicans* was earlier reported from the montane habitats of Africa, Costa Rica, Philippines and Taiwan, between altitudes of 540–2000 m (Swinscow & Krog 1981, Timdal & Krog 2001). In India, the species is distributed in tropical to subtemperate areas in the state of Arunachal Pradesh and Kerala between altitudes 500–1500 m. It is a new record for the country.

Phyllopsora breviuscula (Nyl.) Müll. Arg., Bull. Herb. Boissier 2(App. 1): 45 (1894). Fig. 2

≡ *Lecidea breviuscula* Nyl., Annls Sci. nat., Bot., ser. 4, 19: 339 (1863).

Prothallus thick and reddish brown. Thallus squamulose; squamules adnate, ascending to elongate, crenulate to incised 0.3–1.0 mm wide; upper surface glabrous, pale green to green, plane to convex, sometime fibrillose at the margin. Isidia absent. Cortex 2 type, 20–35 µm thick; medulla containing crystals dissolving in K.

Apothecia common, up to 1.5 mm in diam.; disc plane to convex, reddish-brown; margin slightly raised and glabrous; exciple pale brown; epihymenium hyaline to pale yellow; hymenium hyaline; hypothecium reddish brown, containing crystals which dissolve in K. Ascospores hyaline, simple to fusiform, 6–11 × 2–3.5 µm. Pycnidia not seen.

Chemistry — Thallus K–, C–, KC–, PD–; no lichen substance in TLC.

Specimens examined — **India: Karnataka**, Chikmagalure district, Chamudi Ghat, Kuvettu, alt. 104 m, on bark of trees in evergreen forest, 15.01.2008, H.T. Lumbsch, D.K. Upreti & P.K. Divakar 19740/B (LWG).

Remarks — *Phyllopsora breviuscula* is distinguished by the large, partly imbricate squamules and the reddish brown hypothecium. The Indian specimen

contains crystals in medulla and hypothecium, but no lichen substances were detected in TLC. It is close to *P. parvifolia* in having large squamules and reddish brown prothallus but the latter species differs in forming more plane squamules with phyllidia on the lobe margins in the inner part of the thallus. *P. breviuscula* was earlier known from Cuba, Mauritius, and La Réunion between altitudes of 300–1390 m (Timdal & Krog 2001). In India, the species is collected from tropical areas of Karnataka in western Ghat between altitudes of 100–500 m, and is a new species from the country.

Phyllopsora catervisorediata G.K. Mishra, Upreti & Nayaka, sp. nov. Fig. 3

Mycobank MB 518498

Thallus squamulosus; squamulae ascendentes, elongatae, luteo-virescentes, sorediatae. Apothecia ignota.

Holotype – India: Uttarakhand, Bageshwar district, enroute to Pindari glacier, from Dwali to Khati, alt. 2734–3210 m, on bark, 13.05.2007, S. Joshi & Y. Joshi 07-008932 (LWG).

Etymology: From the latin noun *caterva* (= group or heap), referring to the appearance of the soredia.

Prothallus indistinct. Thallus squamulose, closely adnate, rounded to elongate, sometimes ascending, 0.1–0.5 mm wide; upper surface glabrous, pale green to yellowish, plane to convex, epruinose, sorediate. Soredia farinose, developing from the margin of squamules, forming heaps. Cortex of type 2, 5–10 µm thick; medulla containing crystals dissolving in K.

Apothecia and pycnidia not seen.

Chemistry — Thallus K+ yellow, C–, KC–, PD–; atranorin in TLC.

Remarks — *Phyllopsora catervisorediata* is characterized by the marginally sorediate squamules and the indistinct prothallus. The soredia forms heaps on the margin of the squamules. It is close to *P. soralifera* Timdal, in having sorediate squamules and cortex of type 2, but the latter species differs in having capitate soredia and in lacking lichen substances. *P. catervisorediata* is known from its type locality in the Western Himalayas, where it was found growing on bark of tree in moist and humid forest at an altitude of 2730 m.

Phyllopsora chlorophaea (Müll. Arg.) Zahlbr., Denkschr. Akad. Wiss. Wien 83: 133 (1909). Fig. 4

≡ *Psora chlorophaea* Müll. Arg., Flora 70: 320 (1887).

Prothallus reddish brown to black. Thallus squamulose, ascending, overlapping, elongate, minute 0.1–0.3 mm wide; upper surface glabrous above, pale brown, plane to convex, sometime fibrillose at the margin. Isidia absent. Cortex of type 1–2, 5–10 µm thick; medulla containing crystals that dissolve in K.

Apothecia and pycnidia not seen.

Chemistry — Thallus K–, C–, KC–, PD–; ± atranorin in TLC.

Specimens examined — **India: Karnataka**, Shimoga District, Sharavati Ghat, near Gersoppa, alt. 718 m, in evergreen forest, on bark, 16.01.2008, H.T. Lumbsch, D.K. Upreti & P.K. Divakar 19744Q (LWG), **Orissa**, Ganjam district, foothills of Mahendragiri, Burukhat area, on bark, 04.03.1986, D.D. Awasthi, G. Awasthi, R. Mathur & P. Srivastava 86-184 (LWG-AWAS).

Remarks — *Phyllopsora chlorophaea* is distinguished by minute, lacinulate squamules and reddish brown prothallus. It is close to *P. mediocris* Swinscow & Krog in having reddish-brown prothallus and in cortex type, but the latter species differs in having medium sized, 0.3–1.0 mm wide squamules and in lacking lichen substances. *P. chlorophaea* is a pantropical species earlier reported from montane rainforest and humid woodland in Kenya, Peru, Mauritius, Tanzania, between altitudes of 600–1600 m (Broko 1991, Swinscow & Krog 1981, Timdal & Krog 2001, Timdal 2008). In India, the species is recorded from tropical to subtemperate areas in the states of Karnataka and Orissa, between altitudes of 200–800 m. It is a new to India.

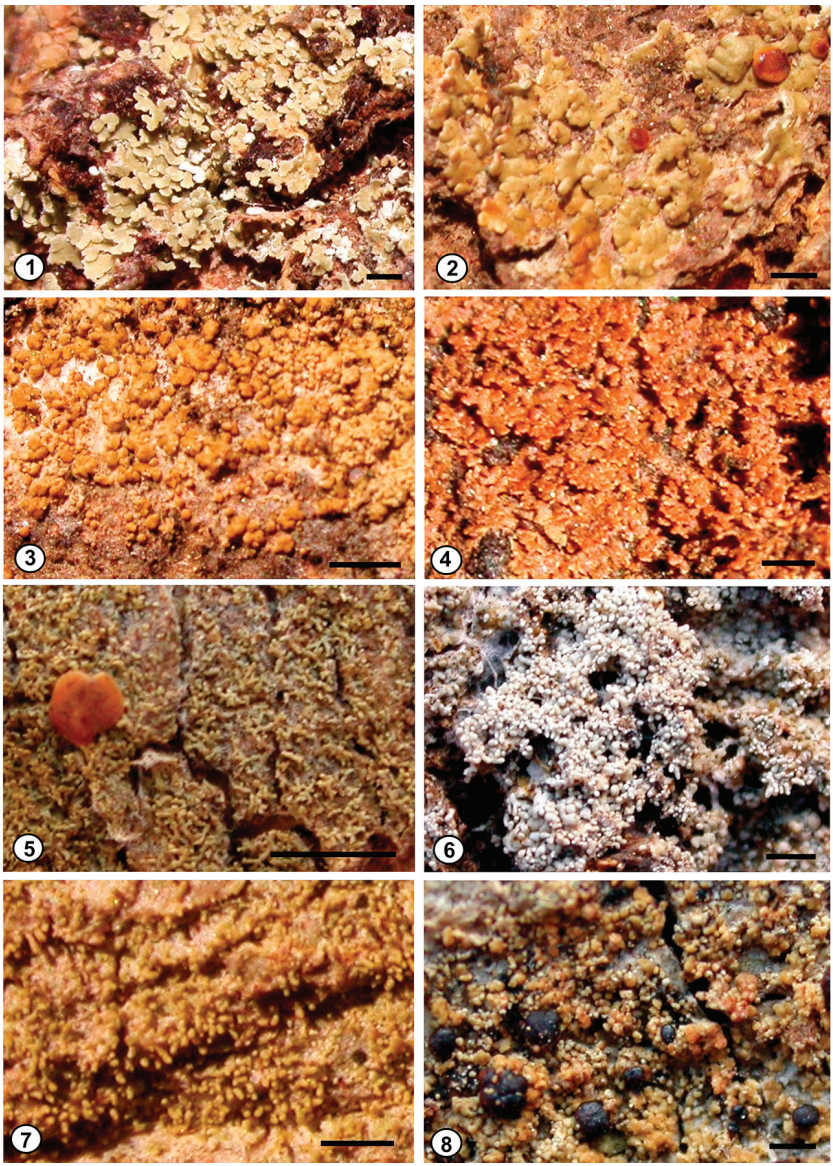
Phyllopsora confusa Swinscow & Krog, Lichenologist 13: 229 (1981). Fig. 5

Prothallus white to reddish brown. Thallus squamulose, adnate to ascending, overlapping, minute, 0.1–0.3 mm wide; upper surface glabrous, pale to green, plane to convex, finely pubescent along the margin. Isidia absent. Cortex of type 2, 10–20 µm thick; medulla containing crystals dissolving in K.

Apothecia common, up to 1.0 mm in diam., disc plane to convex, reddish-brown, margin slightly raised and glabrous; exciple colourless to pale brown; epihymenium hyaline; hymenium colourless; hypothecium reddish brown, containing crystals which dissolve in K. Ascospores hyaline, simple, narrowly ellipsoid, 8–11 × 2–3 µm. Pycnidia not seen.

Chemistry — Thallus K–, C–, KC–, PD–; no lichen substance in TLC.

Specimens examined — **India: Assam**, North Cachar Hills district, Mahur area, on bark, 01.08.2005, D.K. Upreti & J. Rout 05-002958 (LWG), **Himachal Pradesh**, Kangra district, Macleodganj, alt. 1600–1800 m, on *Quercus leucotrichophora* bark, 13.05.2001, D.K. Upreti & S. Nayaka 01-75209 (LWG), **Karnataka**, Shimoga district, Sagara, Holebagilu, alt. 623 m, on bark of *Knema attenuata,* 16.03.2001, S. Nayaka 01-022794 (LWG); Homnemardu Island, alt. 621 m, on bark of *Olea dioica,* 19.03.2001, S. Nayaka 01-66143 (LWG); Muppane, alt. 626 m, on bark of *Memecylon terminale* bark, 21.03.2001, S. Nayaka 01-66193, 01-66169 (LWG); Negiloni, alt. 710 m, on bark, 18.03.2001, S. Nayaka 01-107249 (LWG); 3km before Agumbe Ghat from Koppa, alt. 649 m, on evergreen forest, on bark, 14.01.2008, H.T. Lumbsch, D.K. Upreti & P.K. Divakar 1973/G (LWG); **Kerala**, Ernakulam district, BS Thattekkad, alt. 430 m, on bark, 21.12.2006, B. Haridas 06-009600 (LWG); Palghat district, Parambikulam Wildlife Sanctuary, alt. 610 m, on bark, 14.11.2006, B. Haridas 06-009823, 06-015954 (LWG); M.C.L. Mine area Walayar forest, alt. 300 m, on bark, 22.03.1985, D.D. Awasthi, R. Tiwari & R. Mathur 85.21 (LWG); Siruvani district, alt. 810 m, on bark, 16.11.2006,



Figures 1–8. Habit. 1. *Phyllopsora albicans*; 2. *P. breviuscula*; 3. *P. catervisorediata* (holotype); 4. *P. chlorophaea*; 5. *P. confusa*; 6. *P. corallina var. subglaucella*; 7. *P. furfuracea*; 8. *P. himalayensis*. Bar = 2 mm

B. Haridas 06-009599 (LWG); Trivendrum district, ABP, Athirumala, Pathalamathy, alt. 1250 m, on bark, 25.04.2006, B. Haridas 06-009602 (LWG); **Uttarakhand**, Pauri district, Pauri Kandoliya, on bark of *Cedrus deodara,* 19.06.2005, V. Shukla & Y. Joshi s.n. (LWG).

Remarks — The most characteristic features of *P. confusa* are the minute, ascending squamules and the absence of lichen substances. It is close to *P. isidiotyla* in having reddish-brown prothallus and minute squamules but the latter species differs in having longer ascospores and fibrillose apothecia.

Phyllopsora confusa is a pantropical species earlier reported from montane rainforest and humid woodland in Kenya, La Réunion, Mauritius, and Tanzania between altitudes of 130–2000 m (Brako 1991, Swinscow & Krog 1981, Timdal & Krog 2001). In India, the species is recorded from tropical to temperate areas in the states of Assam, Himachal Pradesh, Karnataka, Kerala, and Uttarakhand and occurs between altitudes of 300–1800 m. It is new to India.

Phyllopsora corallina var. ***subglaucella*** G.K. Mishra, Upreti & Nayaka, var. nov.

MycoBank MB 518499 Fig. 6

Thallus squamulosus; squamulae ascendentes, elongatae, luteo-virescentes. Apothecia convexa, badio-fusca. Ascosporae ellipsoideae.

Holotype – India: Uttarakhand, Pithoragarh district, on way to Thalkedar Temple, alt. 1900–2400 m, on bark, 27.06.1983, D.K. Upreti 212878 (LWG).

Etymology: From the similarity to var. *glaucella.*

Prothallus thin, white to reddish. Thallus squamulose, closely adnate, rounded to elongate, sometimes ascending, 0.1–0.3 mm wide; upper surface glabrous, pale green to yellowish, plane to convex, sometimes fibrillose at the margin, isidiate. Isidia cylindrical, thick, commonly bulbate at the base. Cortex of type 1–2, 5–8 µm thick; medulla containing crystals dissolving in K.

Apothecia common, up to 1.5 mm in diam.; disc plane to convex, brown; margin slightly raised. Exciple colourless; epihymenium hyaline; hymenium colourless; hypothecium colourless to pale brown. Ascospores hyaline, narrowly ellipsoid, 4–8 × 1–2 µm. Pycnidia common, yellow to brown, immersed in thallus; conidia rod-shaped, straight 6–15 × 1–2 µm.

Chemistry — Thallus K+ yellow, C–, KC–, PD–; atranorin in TLC.

Remarks — *Phyllopsora corallina* var. *subglaucella* is distinguished by the cylindrical to bulbate base of the isidia, cortex type 1–2 and presence of atranorin. It is close to the neotropical *P. corallina* var. *glaucella* (Vain.) Brako in having bulbate isidia, but the latter variety differs in having a cortex of type 2 and in containing different lichen substances, mainly vicanicin (Brako 1991).

This species is known from its type locality in the Western Himalayas, where it was found growing on bark of *Quercus leucotrichophora* and *Cedrus deodara* in moist and humid forest between altitudes of 1900–2500 m.

Additional Specimens examined — **India: Uttarakhand**, Bageshwar district, Dhakuri to Khati (en route to Pindari), alt. 2590 m, on bark, 20.05.1950, D.D. Awasthi & A.M. Awasthi 683, 676, 767 (LWG-AWAS); Loharkhet, Pindari Glacier, alt. 1760 m, on bark, 09.05.2007, S. Joshi & Y. Joshi 07-010710 (LWG); Pithoragarh district, Chandak Forest, alt. 1550 m, on *Quercus leucotrichophora,* May 2006, S. Bhatt, 06-009206, 06-010866 (LWG); Gangoli Hat, Hoat Kali Sacred Grove, on *Cedrus deodara,* H. Singh s.n. (LWG); Gori-ganga catchment, East Ghandhura, alt. 1600–2000 m, on bark, 03.10.2002, V. Pant 02000876, 02000880 (LWG); Narain Nagar, alt. 1500 m, on bark, 11.05.1977, O.P. Arora s.n. (LWG); Thakala Forest, alt. 1800m, on bark, 29.10.2002, V. Pant 02000673 (LWG).

Phyllopsora furfuracea (Pers.) Zahlbr., in Engler & Prantl, Nat. Pflanzenfam. 1(1*): 138 (1905). Fig. 7

≡ *Lecidea furfuracea* Pers., in Gaudichaud, Voy. Uran.: 192 (1827).

Prothallus well developed, thin, white. Thallus squamulose; squamules closely adnate, isodiametric, minute, 0.1–0.3 mm wide; upper surface glabrous, yellow green to green, rarely pubescent at margin, isidiate. Isidia common, simple, cylindrical, glabrous, rarely branching, sometimes arising directly from prothallus. Cortex of type 2, 7–10 µm thick; medulla containing crystals dissolving in K.

Apothecia common, up to 0.5–1.0 mm in diam.; disc plane to convex, brown, sometimes fibrillose at base; margin indistinct, paler than the disc. Exciple colourless to pale brown; epihymenium hyaline; hymenium and hypothecium pale brown throughout, the latter containing crystals which dissolve in K. Ascospores hyaline, simple, narrowly ellipsoidal, 5–6(–7) × 2–3 µm. Pycnidia not seen.

Chemistry — Thallus K–, C–, KC–, PD–; furfuraceic acid in TLC.

Specimens examined — **India: Kerala**, Palghat district, Parambikullam, Wildlife Sanctuary, alt. 450 m, on bark, 14.11.2006, B. Haridas, 06-009609 (LWG); Thirssur, Sholayar Range, Mukkanipara, alt. 450 m, on bark, 28.10.2006, B. Hridas 06-009609 (LWG); **Uttarakhand**, Pauri district, Srinagar, Dhari Devi Temple, on *Mangifera indica,* 26.06.2005, V. Shukla & Y. Joshi 05-005278 (LWG); Khirshu, on *Quercus,* 18.06.2005, V. Shukla & Y. Joshi 05-005103 (LWG); Pithoragarh district, Chandak Forest, alt. 1550m, on *Quercus leucotrichophora,* May 2006, S. Bhatt, 06-010888 (LWG); Ginni band, on bark, 30.10.2009, D.K. Upreti, S. Joshi, H. Rai, R. Khare, G.K. Mishra & A. Dwivedi 09-012601 (LWG); Munsiyari, Khuliya Top, alt. 2700-3000 m, on bark, 31.10.2009, D.K. Upreti, S. Joshi, H. Rai, R. Khare, G.K. Mishra & A. Dwivedi 09-012602 (LWG).

Remarks — *Phyllopsora furfuracea* is characterized by minute squamules and isidia directly attached to the prothallus. It is close to *P. nemoralis* in having usually white prothallus and minute squamules but the latter species differs in having smaller isidia and containing argopsin and atranorin. Two other species *P. dolichospora* Timdal & Krog and *P. furfuracea*, are close to *P. furfuracea* in chemistry but they are morphologically different.

The species is a pantropical species earlier reported from montane rainforest and humid woodland of Australia, Belize, Brazil, Colombia Cuba, Cuzco, Dominican Republic, East Africa, Ethiopia, Ecuador, French Guiana, Ivory Coast, Jamaica, Java, Kenya, La Réunion, Loreto, Madagascar, Mexico, Peru, Tanzania, United States, and Venezuela from sea level to an altitude of 2400 m (Brako 1991, Swinscow & Krog 1981, Timdal & Krog 2001, Timdal 2008). It is a new record for the Indian mycota and reported from the states of Kerala and Uttarakhand between altitudes of 300–2500 m.

Phyllopsora himalayensis G.K. Mishra, Upreti & Nayaka, **sp. nov.** Fig. 8

Mycobank MB 518500

Thallus squamulosus; squamulae ascendentes, elongatae, luteo-virescentes. Apothecia convexa, badio-fuscescentia. Ascosporae ellipsoideae vel fusiformes.

Holotypus – India: Himachal Pradesh, Kullu district, Great Himalayan National Park, Shilt, alt. 2800 m, on bark, 04.11.2002, S. Nayaka & R. Srivastava 02-001037 (LWG).

Etymology: From the Himalayas, the type locality.

Prothallus thin, white. Thallus squamulose; squamules closely adnate, rounded to elongate, ascending to overlapping, crenulate to incised, 0.1–0.5 mm wide; upper surface glabrous, pale green to yellow, plane to convex, pubescent along the margin, isidiate. Isidia mostly globular. Cortex of type 1–2, 7–10 µm thick, with scattered crystal dissolving in K; medulla containing crystals dissolving in K.

Apothecia common, up to 2.0 mm in diam.; disc plane to convex, brown to dark brown; margin raised. Exciple colourless; epihymenium hyaline to pale yellow; hymenium colourless; hypothecium colourless to pale yellow, containing crystals which dissolve in K. Ascospores hyaline, simple, narrowly ellipsoid to fusiform, 5–10 × 1–2.5 µm. Pycnidia common, orange to brown, immersed in the thallus; conidia rod-shaped, straight, 6–12 × 1–1.5 µm.

Chemistry — Thallus K+ yellow, C–, KC–, PD–; atranorin in TLC.

Additional Specimens examined — **India: Himachal Pradesh**, Kullu district, Great Himalayan National Park, Shilt, alt. 2800 m, on bark, 04.11.2002, S. Nayaka & R. Srivastava, 02-001152, 02-001113, 02-001077 (LWG); Pardi, alt. 3140 m, on bark, 05.11.2002, S. Nayaka & R. Srivastava, 02-001244 (LWG); **Uttarakhand**, Bageshwar district, Dhakuri to Khati, en route to Pindari Glacier, alt. 2210–2734 m, on bark, 20.05.1950, D.D. Awasthi & A.M. Awasthi, 683 (LWG-AWAS); 12.05.2007, S. Joshi & Y. Joshi, 07-008931 (LWG); Tehri Garhwal, above Jamnotri, alt. 3657 m, on bark of *Quercus* tree, 22.06.1951, D.D. Awasthi 904 (LWG-AWAS).

Remarks — *Phyllopsora himalayensis* is distinguished by the rounded to elongate, convex, pale green to yellow squamules, the globular isidia, and the colourless to pale yellow hypothecium. The new species is close to *P. kalbii* in

having globular isidia and dark brown apothecia, but *P. himalayensis* differs in having a cortex of type 2 and in lacking lichen substances.

Phyllopsora himalayensis occurs in temperate areas of the Himalayas in Himachal Pradesh and Uttarakhand between alt. 1500–3140 m. It grows on rough bark trees in moist and humid forests.

Phyllopsora isidiotyla (Vain.) Riddle, Mycologia 15: 81. (1923). Fig. 9

≡ *Lecidia isidiotyla* Vain., Etud. Lich. Bresil 2: 49 (1890).

Prothallus thick pale brown. Thallus squamulose; squamules adnate, granular to elongate, minute, 0.1–0.3 mm wide; upper surface glabrous, yellowish-green, fibrillose at the margin, isidiate. Isidia abundant, thick, cylindrical, rarely branched. Cortex thin, gelatinous, to 5 µm thick; medulla containing crystals dissolving in K.

Apothecia common, up to 1.0 mm in diam.; disc plane to convex, yellow-brown to brown; margin raised. Exciple pale yellow; epihymenium hyaline to pale yellow; hymenium golden yellow; hypothecium pale yellow-brown, containing crystals which dissolve in K. Ascospores hyaline, simple, ellipsoid to fusform, 6–11 × 1–2 µm. Pycnidia not seen.

Chemistry — Thallus K+ yellow, C–, KC–, PD–; atranorin in TLC.

Specimens examined — **India: Assam**, North Cachar Hills district, Haflong, on bark, 01.08.2005, D.K. Upreti & J. Rout 05-002963 (LWG); **Bihar**, Pachim Champaran district, Don Hills, Devatapatta, on bark, 20.02.1995, D.K. Upreti & J. Tandon 213288 (LWG); **Himachal Pradesh**, Chamba district, in and around Khajiar, alt. 2000 m, on bark, 15.05.2001, D.K. Upreti & S. Nayaka 01-75441 (LWG); **Karnataka**, Shimoga district, Sagara, Moolagadde, alt. 600 m, on bark of *Calycopetris floribunda,* 22.3.2001, S. Nayaka 01-104966 (LWG); **Kerala**, Palghat district, Sailent valley National Park, alt. 810 m, on bark, 16.11.2006, B. Haridas, 06-007945 (LWG); **Sikkim**, South Sikkim district, 20 km before Temi tea, state, alt. 1500 m, on bark, 31.03.2001, D.K. Upreti & S. Chatterjee 01-26673 (LWG); South Sikkim district, Narnchi 15 km towards Jagthang, alt. 1000 m, on bark, May 2006, D.K. Upreti & S. Chatterjee 219565 (LWG); **Tamil Nadu**, Palni Hills, Perumal to Palni road side, via short cut road, alt 1524 m, on bark, 15.12.1970, K. P. Singh 70.951 (LWG-AWAS); **Uttarakhand**, Pauri district, near Kiyonkaleshwar Temple, on *Pinus,* 19.06.2005, V. Shukla & Y. Joshi 05-005449, 05-005443 (LWG); Pithoragarh district, Chandak Forest, alt. 1500 m, on *Quercus leucotrichophora,* May 2006, S. Bhatt 06-001088/B (LWG); Gori-ganga catchment, Thakala forest, alt. 1400 m, on bark of *Madhuca longifolia,* 29.10.2002, V. Pant 02000616 (LWG); Saurlekh forest area, Near Microwave Station, alt. 2700 m, on bark, 30.09.1990, D.K. Upreti & G.N. Hariharan 202253 (LWG); on way to Thalkedar temple, alt. 1900–2400 m, on bark, 27.06.1993, D.K. Upreti 212849/B (LWG).

Remarks — *Phyllopsora isidiotyla* is distinguished by abundant isidia and granular squamules. It is close to *P. furfuracea* in having minute squamules and thick isidia, but the latter species contains furfuraceic acid.

The species is earlier reported from Brazil, Costa Rica, Venezuela, and United States, from sea level to an altitude of 3000 m (Brako 1991). In India

it is known from tropical to temperate areas in the states of Assam, Himachal Pradesh, Karnataka, Kerala, Sikkim, Tamil Nadu, and Uttarakhand, between altitudes of 600–2700 m. It is new to the Indian lichen biota.

Phyllopsora kalbii Brako, Flora Neotropica Monograph 55: 51 (1991). Fig. 10

Prothallus thin, white to pale brown. Thallus squamulose; squamules closely adnate to overlapping, crenulate to incised, 0.1–0.3 mm wide; upper surface glabrous, pale green, convex, pubescent along the margin, isidiate. Isidia mostly globular. Cortex of type 2, 5–17 µm thick; medulla containing crystals dissolving in K.

Apothecia common, up to 2.0 mm in diam.; disc plane to convex, brown to black; margin raised. Exciple pale brown; epihymenium hyaline; hymenium pale yellow; hypothecium colourless to pale yellow-brown, containing crystals which dissolve in K. Ascospores hyaline, simple, narrowly ellipsoid to fusiform, 5–12 × 2–3 µm. Pycnidia yellowish; conidia straight, 4–6 × 1 µm.

Chemistry — Thallus K–, C–, KC–, PD–; no lichen substance in TLC.

Specimens examined — **India: Madhya Pradesh**, Dindori district, 13 km, before Kabir from Chauradader, alt. 640 m, on *Shorea robusta* tree trunk, 06.07.2005, D.K. Upreti, S. Nayaka & Satya 05-005704 (LWG); Around Jagatpur Forest Rest House, alt. 640 m, on *Shorea robusta* tree trunk, 05.07.2005, D.K. Upreti, S. Nayaka & Satya 05-005578 (LWG); Tarwartola near to Chauradeder, alt. 640 m, on *Shorea robusta* tree trunk, 06.07.2005, D.K. Upreti, S. Nayaka & Satya 05-005662, 05-005882/B (LWG).

Remarks — *Phyllopsora kalbii* is distinguished by the globular isidia, mostly rounded, convex squamules, and brown to black apothecia. It is close to *P. corallina* var. *santensis* (Tuck.) Brako in having globular to cylindrical isidia and dark brown apothecia, but the latter taxon differs in chemistry (mainly argopsin).

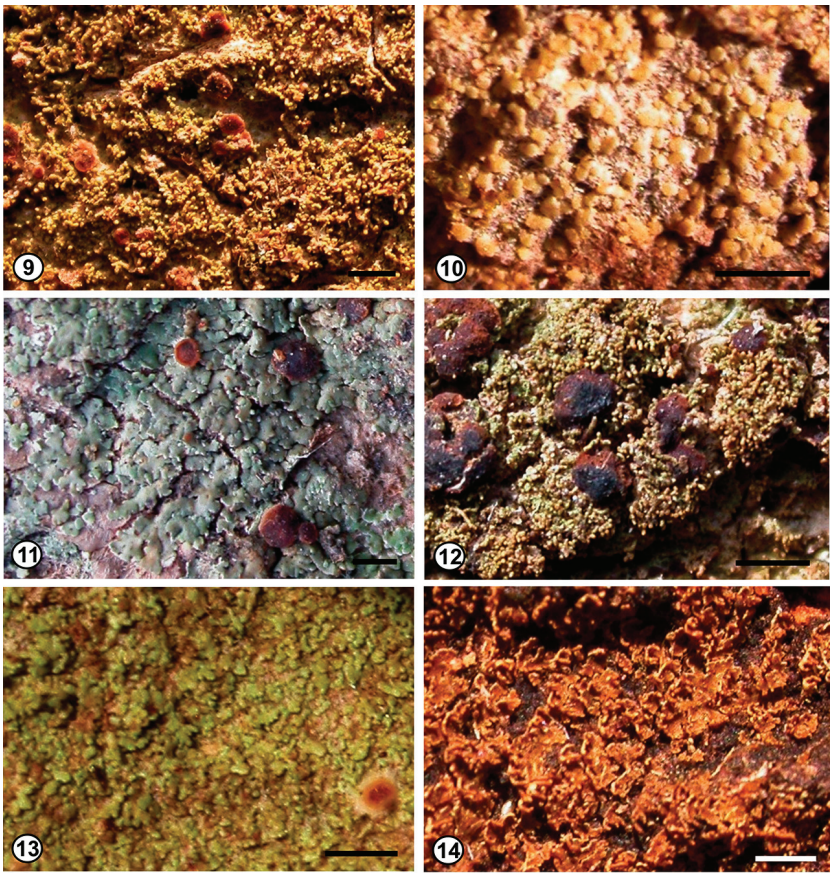
The species is a pantropical species earlier reported from Brazil, Dominican Republic, Kenya, Tanzania, and United States between altitudes of 300–2400 m (Brako 1991). In India, *P. kalbii* is known from tropical areas in the state of Madhya Pradesh, between altitudes of 300–650 m. It is new to the Indian lichen biota.

Phyllopsora mauritiana (Taylor) Gotth. Schneid., Biblioth. Lichenol. 13: 177 (1980, '1979'). Fig. 11

≡ *Lecidea mauritiana* Taylor, London J. Bot. 6: 151 (1847).

Prothallus thick, reddish-brown. Thallus squamulose; squamules closely adnate, overlapping, mostly isodiametric, 0.3–1.0 mm wide; upper surface glabrous, green, plane to convex, fibrillose at the margin. Isidia absent. Cortex of type 2, 8–20 µm thick; medulla containing crystals dissolving in K.

Apothecia common, up to 1.0 mm in diam.; disc plane to convex, pale brown



Figures 9–14. Habit. 9. *Phyllopsora isidiotyla*; 10. *P. kalbii*; 11. *P. mauritiana*; 12. *P. nemoralis*; 13. *P. subcrustacea*; 14. *P. swinscowii*. Bar = 2 mm

to brown; margin slightly raised and sometimes fibrillose. Exciple colourless to brown; epihymenium hyaline; hymenium hyaline to yellowish; hypothecium golden yellow, containing crystals which dissolve in K. Ascospores hyaline, simple, bacilliform, narrowly ellipsoid to fusiform, 6–9 × 1–2 µm. Pycnidia yellowish; conidia straight, 4–8 × 1 µm.

Chemistry — Thallus K–, C–, KC–, PD–; no lichen substances in TLC.

Specimens examined — **India: Kerala**, Palghat district, Siruvani, alt. 810 m, on bark, 16.11.2006, B. Haridas 06-009686, 06-009824 (LWG); **Tamil Nadu**, Palni Hills, Kodaikanal road, on way to Gumparai, alt. 914 m, on bark, 23.12.1970, K.P. Singh 70.1268 (LWG-AWAS); Shola near 18th mile of Kodaikanal road, alt. 1066 m, G. Foreau, S. J. 4141 (LWG-AWAS).

Remarks — The most characteristic feature of *P. mauritiana* is large, adnate, mostly isodiametric squamules, and golden yellow hypothecium. It is close to *P. breviuscula* in squamule and prothallus characters, but the later species forms thicker, elongated lobes.

Phyllopsora mauritiana was earlier reported from humid submontane forest in Tanzania and Mauritius between altitudes of 600–1500 m (Timdal & Krog 2001). In India it is recorded from tropical to temperate areas in the state of Kerala and Tamil Nadu between altitudes of 800–1066 m. It is a new species for the country.

Phyllopsora nemoralis Timdal & Krog, Mycotaxon. 77: 85 (2001). Fig. 12

Prothallus thin, reddish brown. Thallus squamulose; squamules adnate, granular to elongate, minute, 0.1–0.3 mm wide; upper surface glabrous, green, fibrillose at the margin, isidiate. Isidia abundant, thin, short, cylindrical, rarely branched. Cortex of type 1–2, 10–15 µm thick; medulla containing crystals dissolving in K.

Apothecia common, up to 2.0 mm in diam.; disc plane to convex, dark brown to black; margin raised. Exciple colourless; epihymenium hyaline; hymenium colourless; hypothecium pale brown, containing crystals which dissolve in K. Ascospores hyaline, simple, ellipsoid to fusform, 6–11 × 1–2 µm. Pycnidia not seen.

Chemistry — Thallus K+ yellow, C–, KC–, PD–; containing ± argopsin and atranorin in TLC.

Specimens examined — **India: Assam**, North Cachar Hills district, Hoflong, on bark, 01.08.2005, D.K. Upreti & J. Rout 05-003568 (LWG); Mahur, on bark, Sept. 2005, D.K. Upreti & J. Rout 05-009945/A (LWG).

Remarks — *Phyllopsora nemoralis* is characterized by the thin, small, short isidia and the colourless hymenium. It is close to *P. halei* (Tuck.) Zahlbr., in having a reddish brown prothallus and in the presence of atranorin, but that species differs in having thick, erect isidia and a dark reddish brown hypothecium. The other isidiate species, *P. isidiotyla,* differs in cortex type, while *P. furfuracea* contains furfuraceic acid.

Phyllopsora nemoralis was earlier known from woodland in Tanzania, La Réunion and South Africa between altitudes of 1550–2010 m (Timdal & Krog 2001). In India it is recorded from temperate areas in the state of Assam at an altitude of 1014 m. The species is new to the Indian lichen biota.

Phyllopsora subcrustacea (Malme) Brako, Mycotaxon 35(1): 15, 1989. Figure 13

≡ *Lecidea corallina* var. *subcrustacea* Malme, Ark. Bot. 28A(7): 47. 1936.

Prothallus thick, reddish brown to red. Thallus squamulose; squamules first adnate, later ascending, overlapping, minute 0.1–0.3 mm wide; upper surface

glabrous, yellow-green to green, plane to convex, finely pubescent along the margin. Isidia absent. Cortex of type 2, 8–20 µm thick, medulla containing crystals dissolving in K.

Apothecia common, up to 1.5 mm in diam.; disc plane to convex, reddish-brown; margin slightly raised and fibrillose. Exciple colourless to pale brown; epihymenium hyaline; hymenium colourless to pale yellow; hypothecium golden yellow, containing crystals which dissolve in K. Ascospores hyaline, simple, narrowly ellipsoid to fusiform, 12–21 × 2–3 µm. Pycnidia not seen.

Chemistry — Thallus K–, C–, KC–, PD–; no lichen substances in TLC.

Specimens examined — **India: Karnataka**, Shimoga district, Sagara to Talgappa, Ulanhalli, alt. 697 m, on bark in evergreen forest, 16.02.2008, H.T. Lumsch, D.K. Upreti & P.K. Divakar 19742/0/2 (LWG); Sagara, Muppane, alt. 626 m, on bark, 21.03.2001, S. Nayaka 01-66191 (LWG); Shavauti River Basin, Holebagilu, alt. 650 m, on bark of *Diospyros crumenata*, 16.03.2001, S. Nayaka 01-222798, 01-22276 (LWG); **Kerala**, Idukki district, Adimali Forest range, Chekuthon Mukku, alt. 750 m, on *Turpinia malabarica* bark, 16.02.2006, B. Haridas 06-009606 (LWG); Palghat district, Parambikulam Wildlife Sanctuary, alt. 800 m, on bark, 14.11.2006, B. Haridas 06-009603 (LWG).

Remarks — *Phyllopsora subcrustacea* is characterized by the minute, adnate to ascending squamules and the fibrillose apothecia. It is close to *P. manipurensis* in having adnate squamules and in the absence of lichen substances but that species differs in having small ascospores 5–10 × 2–2.5 µm and a white prothallus.

The species was earlier reported only from Paraguay (Brako 1991). In India this species is known from tropical areas in the states of Karnataka and Kerala between the altitudes of 300–800 m. It is new for the country.

Phyllopsora swinscowii Timdal & Krog, Mycotaxon 77: 88 (2001). Fig. 14

Prothallus thick, red to reddish brown. Thallus squamulose; squamules adnate, overlapping, isodiametric, scattered when young, slightly imbricate, crenulate to incised, 0.3–1.0 mm wide; upper surface glabrous, greenish to yellowish-brown, sometimes pubescent along the margin, isidiate. Isidia common, simple, cylindrical, medium thick, attached to the margin of the squamules. Cortex of type 1–2, 5–10 µm thick; medulla containing crystals dissolving in K.

Apothecia common, up to 1.5 mm in diam.; disc plane to convex, pale brown to brown; margin slightly raised. Exciple colourless; epihymenium hyaline; hymenium golden yellow; hypothecium colourless to pale yellow-brown, containing crystals which dissolve in K. Ascospores hyaline, simple, narrowly ellipsoid to fusiform, 5–8 × 1–2 µm. Pycnidia not seen.

Chemistry — Thallus K–, C–, KC–, PD+ orange; methyl 2,7-dichloropsoromate and methyl 2,7-dicholoronorpsoromate in TLC.

Specimens examined — **India: Karnataka**, Shimoga district, Sagara, Mattikoppa, alt. 603 m, on bark of *Holigarna* sp., 17.03.2001, S. Nayaka, 01-67383, 01-67390 (LWG);

Hubse, alt. 594 m, on bark of *Diospyros crumenata,* S. Nayaka 01-222743, 01-67393/B (LWG); **Kerala**, Idukki district, Pariyar Tiger, Reserve, Thekkady, Cheveloda, on bark, 22.03.2006, B. Haridas, 06-007969 (LWG).

Remarks — *Phyllopsora swinscowii* is characterized by the PD+ orange reaction and the red, thick prothallus. It is close to *P. africana* Timdal & Krog, and *P. martinii* Swinscow & Krog in having a PD+ orange reaction but both those species contain different lichen substances.

The species has earlier been reported from woodland in East Africa, Kenya, Mauritius, and Tanzania between altitudes of 300–1900 m (Timdal & Krog 2001). In India it is recorded from tropical areas in the states of Karnataka and Kerala, between altitudes of ca. 100–600 m. It is a new species for the country.

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Literature cited

Awasthi DD. 2007. A compendium of the macrolichens from India, Nepal and Sri Lanka. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.

Brako L. 1989. Reevalutaion of the genus *Phyllopsora* with taxonomic notes and introduction of *Squamacidia* gen. nov. Mycotaxon 35: 1–19.

Brako L. 1991. *Phyllopsora (Bacidiaceae)*. Fl. Neotrop. Monogr. 55: 1–66.

Elix JA. 2006a. Five new species of *Phyllopsora* (lichenized *Ascomycota*) from Australia. Australas. Lichenol. 58: 4–13.

Elix JA. 2006b. Additional lichen records from Australia 62. Australas. Lichenol. 60: 6–12.

Swinscow TDV, Krog H. 1981. The genus *Phyllopsora,* with a report on East African species. Lichenol. 13(3): 203–247. doi:10.1017/S0024282981000315

Timdal E, Krog H. 2001. Further studies on African species of the lichen genus *Phyllopsora* (*Lecanorales*). Mycotaxon 77: 57–89.

Timdal E. 2008. Studies on *Phyllopsora (Ramalinaceae)* in Peru. Lichenol. 40(4): 337–362.

Upreti DK, Divakar PK, Nayaka S. 2003. Notes on species of the lichen genus *Phyllopsora* in India. Biblioth. Lichenol. 86: 185–191.

Walker FJ, James PW. 1980. A revised guide to microchemical techniques for the identification of lichen products. Bull. Brit. Lich. Soc. 46(Suppl.): 13–29.